

# Physical and Mental Health Status of Gulf War and Gulf Era Veterans

## *Results From a Large Population-Based Epidemiological Study*

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**Objective:** The aim of the study was to report the mental and physical health of a population-based cohort of Gulf War and Gulf Era veterans 20 years after the war. **Methods:** A multimode (mail, Web, or computer-assisted telephone interviewing) health survey of 14,252 Gulf War and Gulf Era veterans. The survey consisted of questions about general, physical, mental, reproductive, and functional health. **Results:** Gulf War veterans report a higher prevalence of almost all queried physical and mental health conditions. The population as a whole, however, has a significant burden of disease including high body mass index and multiple comorbid conditions. **Conclusions:** Gulf War veterans continue to report poorer health than Gulf Era veterans, 20 years after the war. Chronic disease management and interventions to improve health and wellness among both Gulf War and Gulf Era veterans are necessary.

In 1995, the Department of Veterans Affairs (VA) designed and implemented a large population-based cohort study of Gulf War and Gulf Era veterans (ie, those who served during the same time period but did not deploy to the Gulf War) called “The National Health Survey of Gulf Era Veterans and Their Families.”<sup>1</sup> Impetus for this study was based, in part, on growing concern among veterans that the unique illness and symptoms they were experiencing were somehow related to their service in the Gulf War.<sup>2,3</sup> The main objective of this study was to compare the health status and functioning of Gulf War veterans with Gulf Era veterans in the 5 years after the war. Initial results from this study identified several differences between the two groups. Gulf War veterans reported a higher prevalence of a multitude of health issues, including functional impairment, unexplained symptoms, medical conditions, and health care utilization.<sup>1</sup> In addition, they reported poorer general health than their nondeployed counterparts.<sup>1</sup>

In 2012 to 2013, VA initiated a follow-up of the cohort almost 20 years after the baseline survey, with the primary goal of reporting on the health of Gulf War veterans and comparing it with Gulf Era veterans two decades after the war. Although there have been several longitudinal cohort studies of Gulf War veterans, previous studies have been limited to 10 years after baseline assessment; the sample sizes have been smaller; and only one study included a nondeployed comparison group.<sup>4–7</sup> This paper reports on

comparisons of physical and mental health outcomes between the Gulf War deployed and Gulf Era (nondeployed) at the time of the most recent assessment.

## METHODS

### Study Population

Data for this study came from the 2012 “Follow-up Study of a National Cohort of Gulf War and Gulf Era Veterans,” the second follow-up to the 1995 “National Health Survey of Gulf War Era Veterans and Their Families.”<sup>1</sup> The sampling, design, and response rates to the 1995 study have been discussed in detail elsewhere.<sup>1</sup> In short, a population-based permanent panel of 15,000 Gulf War veterans and 15,000 Gulf Era veterans was constructed using stratified sampling design. The 15,000 Gulf War veterans were sampled from the 693,826 US troops identified by the Department of Defense, Defense Manpower Center (DMDC) as having been deployed to the Gulf War. The 15,000 Gulf War Era veterans were sampled from 800,690 persons (half of all those who were in the military between September 1990 and May 1991) identified by DMDC as having served during that time period but not deployed to the Gulf War. Both groups had representation from each branch of service (Air Force, Army, Marines, Navy). Women, National Guard, and reserve were oversampled.<sup>1</sup> The veterans invited to participate in the 2012 follow-up study were all 28,374 living panel members of the original sample of 30,000 contacted in 1995.

### Data Collection Methods

The sequential multimode design used Web, mail, and computer-assisted telephone interviewing (CATI). Survey mailings used a modified Tailored Design.<sup>8</sup> An advance letter was mailed to all 28,374 living panel members inviting them to complete the survey online using a unique Web personal identification number. Nonresponders received a reminder letter about the online survey after up to three mailed questionnaire packets and thank you/reminder postcards. The advance letter was sent to panel members in September 2012 with a reminder postcard mailed 2 weeks later. Three mailings of paper questionnaires occurred at monthly intervals (October 2012, November 2012, and January 2013), with reminder postcards a week after each questionnaire mailing. The mailings contained a 16-page scannable structured health questionnaire, a preaddressed and prepaid return envelope, two informed consent forms (one to sign and send back, and one for the veteran to keep), an information sheet which included telephone numbers for study information, the VA Crisis Line, and VA benefits assistance. In March 2013, CATI calls were made to the 14,139 veterans who had not responded to the Web or paper survey. The study protocol and all documents were approved by the Washington DC VA Medical Center Institutional Review Board. All data collection was completed by the end of 2013.

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Funding support was provided by the Department of Veterans Affairs Post Deployment Health Epidemiology Program.

The authors report no conflict of interest.

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DOI: 10.1097/JOM.0000000000000627

## Measures

The posttraumatic stress disorder (PTSD) Checklist Civilian Version (PCL-C) was used to assess PTSD symptomology. The PCL-C is the most frequently used self-report measure of PTSD symptoms.<sup>9</sup> It is widely used clinically to aid diagnosis and track symptom improvement, and in research for screening or epidemiological assessment. Validation studies of the PCL-C have reported alphas for internal consistency in the mid to high 0.90s. The PCL-C correlates highly with gold-standard symptom interviews.<sup>10</sup> For this study, a score of 50 or higher was considered a positive screen for PTSD.<sup>10</sup> A study that reviewed and validated the sensitivity and specificity of different cutoff points for a positive PTSD screening with the PCL-C found that a cutoff of 48 or 50 was most suitable for accurately estimating population prevalence in general population samples, with a result that maximizes positive predictive value, but concomitantly accepts a high rate of false-negatives.<sup>11</sup>

The Patient Health Questionnaire (PHQ) was used to assess depression, somatic symptoms, and alcohol abuse. The PHQ is a validated self-report instrument that was developed for the primary care setting to screen for several mental disorders (depressive, anxiety, somatoform, alcohol, and eating disorders) and has been found to be highly consistent with DSM diagnostic criteria.<sup>12,13</sup> Depression symptomology was measured using the PHQ-9, which has been validated as both a screener and a severity measure.<sup>14</sup> A veteran was considered to have symptoms consistent with major depressive disorder if five of nine depressive symptoms were present at least “more than half the days” in the past 2 weeks and at least one of those symptoms was depressed mood or anhedonia, or if the veteran endorsed the final question in the assessment: “thoughts that you would be better off dead or hurting yourself in some way.” A positive screen for other depressive syndrome was defined as a report of two to four symptoms for “more than half the days” and one of those symptoms was depressed mood or anhedonia. Veterans were considered to have other anxiety syndrome if they answered “several days” or “more than half the days” to “feeling nervous, anxious, on edge, or worrying a lot about different things” and at least three of the following were reported as “more than half the days”: “feeling restless so that it is hard to sit still,” “getting tired very easily,” “muscle tension, aches, or soreness,” “trouble falling asleep or staying asleep,” “trouble concentrating on things such as reading a book or watching TV,” “becoming easily annoyed or irritable.”

The PHQ-15 was used to measure somatic symptoms; this instrument has also been validated and widely used in the primary care setting.<sup>15</sup> Each symptom had three levels of response: not bothered (scored as 0), bothered a little (scored as 1), and bothered a lot (scored as 2). Veterans with a score of 15 or more were considered to have high somatic symptom severity.<sup>15</sup>

Irritable bowel syndrome and functional dyspepsia were ascertained by the ROME criteria.<sup>16</sup> Veterans were considered to have irritable bowel syndrome if they had recurrent abdominal pain or discomfort for at least 3 days per month in the last 3 months that was associated with two or more of the following: improvement with defecation, onset associated with a change in frequency of stool, or onset associated with a change in form/appearance of stool.<sup>17</sup> Veterans were considered to have functional dyspepsia if one or more of the following was present: bothersome postprandial fullness, early satiation, epigastric pain, or epigastric burning.<sup>18</sup>

Additional health outcomes of interest included self-reported medical conditions (“Has a doctor ever told you that you have any of the following conditions?”) and health care utilization (“During the past 12 months how many clinic or doctor visits have you made because you were sick?” and “During the past 12 months how many times have you been hospitalized overnight or longer?”). A subset of respondents ( $N=2500$ ) who indicated that they had a doctor's

visit or hospitalization in the past year were invited to participate in medical records validation of self-reported reasons for doctors' visits and hospitalizations.

Other covariates include age, sex, race, service branch, unit component, body mass index (BMI), and smoking status. Age at time of Gulf War (17–25, 26–32, 33–39, 40+), sex (male and female), and race (white non-Hispanic, black non-Hispanic, Hispanic, other non-Hispanic) were self-reported, whereas information on service branch (Air Force, Army, Marines, Navy) and unit component (active duty, National Guard, reserve) came from the sampling frame. BMI was calculated using self-reported height and weight. Smoking status was ascertained from the following question: “Have you smoked cigarettes in the past 12 months?” Veterans who endorsed “yes” were classified as current smokers; veterans who endorsed “never smoked” were classified as non-smokers; and veterans who endorsed “no” were classified as former smokers.

## Analysis

All analyses were stratified by deployment to the 1991 Gulf War. Weights were calculated and applied to account for the stratified sampling design and nonresponse. Probability weights were computed as the ratio of the frame counts to the sample counts. To adjust for nonresponse the weights were calibrated so that the weighted totals of the stratification cells, which included deployment, sex, unit component (sampling frame components) and age group, race, and rank (highly significant in propensity for responding to the 2012 study), summed to the population totals.

Unweighted frequencies, weighted percent (population prevalence estimates), weighted adjusted odds ratios (aORs), and 95% confidence intervals (CIs) for all health outcomes were produced using PROC SURVEY. Odds ratios were adjusted for age, sex, race, service branch, unit, BMI, and smoking status. All analyses were performed using SAS 9.4.<sup>19</sup>

## RESULTS

### Demographic and Military Characteristics

A total of 14,252 (50% response) veterans responded to the survey. The majority of those veterans responded by mail (67.7%), followed by Web (26.7%) and CATI (5.6%). Table 1 provides the demographic and military characteristics of the study sample; these data are unweighted. More Gulf War veterans responded ( $n=8104$ ; 56.8%) than Gulf Era veterans ( $n=6148$ ; 43.1%). When compared with Gulf Era veterans, Gulf War veterans were more likely to be African American, be separated or divorced, have less education, and have been in the National Guard ( $P<0.05$ ).

### Self-Reported Medical Conditions

The population prevalence of chronic medical conditions in order of descending magnitude of the aORs comparing Gulf War veterans with Gulf Era veterans is reported in Table 2. Unweighted frequencies and weighted percentages and weighted aORs are reported. Gulf War veterans reported a significantly higher prevalence of Gulf War Illness presenting as chronic multisymptom illness (43.9% vs 20.3%; aOR = 2.36; 95% CI: 1.94, 2.86), chronic fatigue syndrome (11.8% vs 5.3%; aOR = 2.36; 95% CI: 1.94, 2.86), neuralgia (9.4% vs 6.3%; aOR = 1.65; 95% CI: 1.40, 1.95), gastritis (20.2% vs 14.3%; aOR = 1.59; 95% CI: 1.35, 1.73), chronic obstructive pulmonary disease (8.4% vs 6.3%; aOR = 1.48; 95% CI: 1.23, 1.78), fibromyalgia (3.7% vs 2.9%; aOR = 1.48; 95% CI: 1.15, 1.91), tachycardia (8.1% vs 5.9%; aOR = 1.47; 95% CI: 1.20, 1.79), dermatitis (27.4% vs 21.1%;

**TABLE 1.** Demographic and Military Characteristics of Study

Characteristic	Gulf War Veterans	Gulf Era Veterans
	(n = 8,104)	(n = 6,148)
	N (%)	N (%)
Sex		
Male	6,532 (80.6)	4,837 (78.7)
Female	1,572 (19.4)	1,311 (21.1)
Race*		
White non-Hispanic	5,569 (70.2)	4,358 (72.8)
Black non-Hispanic	1,532 (19.3)	1,034 (17.3)
Hispanic	551 (6.9)	374 (6.2)
Other non-Hispanic	284 (3.6)	220 (3.7)
Age in 1991*		
17–25	2,846 (35.2)	1,834 (29.9)
26–32	2,249 (27.8)	1,606 (26.1)
33–39	1,420 (17.5)	1,264 (20.6)
40+	1,581 (19.5)	1,438 (23.4)
Marital status*		
Married	5,545 (69.1)	4,347 (71.3)
Separated	242 (3.0)	157 (2.5)
Divorced	1,257 (15.7)	907 (14.9)
Widowed	140 (1.7)	114 (1.9)
Single, never married	553 (6.9)	364 (6.0)
Single, living with partner	290 (3.6)	206 (3.4)
Branch		
Air Force	1,006 (12.4)	813 (13.2)
Army	5,216 (64.4)	3,954 (64.3)
Marine	835 (10.3)	603 (6.0)
Navy	1,047 (12.9)	778 (12.7)
Unit component		
Active Duty	2,985 (36.8)	2,582 (42.0)
National Guard	2,332 (28.8)	1,561 (25.4)
Reserve	2,787 (34.4)	2,005 (32.6)
Education*		
Did not finish high school	79 (1.0)	61 (1.0)
High school/GED	1,500 (18.6)	884 (14.4)
Some college, no degree	2,411 (30.0)	1,674 (27.4)
Associate's degree	1,123 (14.0)	828 (13.6)
Bachelor's degree	1,671 (20.8)	1,398 (22.9)
Masters/doctorate/professional degree	1,266 (15.7)	1,263 (20.7)
Annual income*		
<\$20,000	693 (8.8)	453 (7.5)
\$20,000–\$34,999	1,016 (12.9)	665 (11.1)
\$35,000–\$49,999	1,192 (15.1)	872 (14.5)
\$50,000–\$74,999	1,867 (23.7)	1,305 (21.7)
\$75,000–\$99,999	1,207 (15.3)	980 (15.3)
>\$100,000	1,910 (24.2)	1,727 (28.8)

\*Self-reported; there are missing data.  
GED, General education diploma.

aOR = 1.44; 95% CI: 1.27, 1.63), rheumatoid arthritis (9.9% vs 7.9%; aOR = 1.40; 95% CI: 1.17, 1.67); seizures (2.7% vs 2.0%; aOR = 1.38; 95% CI: 1.03, 1.85), coronary heart disease (5.6% vs 5.3%; aOR = 1.32; 95% CI: 1.09, 1.59), migraine headaches (20.3% vs 16.1%; aOR = 1.30; 95% CI: 1.15, 1.47), hypertension (43.0% vs 40.0%; aOR = 1.22; 95% CI: 1.10, 1.35), asthma (10.2% vs 9.0%; aOR = 1.22; 95% CI: 1.04, 1.44), and unspecified arthritis (33.9% vs 31.8%; aOR = 1.16; 95% CI: 1.05, 1.29). Applying the ROME

criteria, Gulf War veterans also had a significantly higher prevalence of irritable bowel syndrome (24.4% vs 14.3%; aOR = 2.10; 95% CI: 1.79, 2.45) and functional dyspepsia (27.7% vs 15.9%; aOR = 1.94; 95% CI: 1.75, 2.17) compared with Gulf Era veterans.

**Mental Health Disorders**

Unweighted frequencies, weighted prevalence estimates, and weighted aORs for screening positive for five mental health conditions and deployment status are provided in Table 3. Gulf War veterans had a significantly higher prevalence of positive screens for each of the five conditions assessed in this study: PTSD in the past 4 weeks (20.9% vs 11.5%; aOR = 1.93; 95% CI: 1.67, 2.24), major depressive disorder in the past 2 weeks (32.9% vs 22.9%; aOR = 1.56; 95% CI: 1.41, 1.73), other depressive disorder in the past 2 weeks (23.5% vs 19.1%; aOR = 1.24; 95% CI: 1.08, 1.38), other anxiety disorder in the past 4 weeks (18.7% vs 14.4%; aOR = 1.34; 95% CI: 1.17, 1.54), and high somatic symptom severity in the past 4 weeks (16.1% vs 8.3%; aOR = 2.10; 95% CI: 1.79, 2.45).

**Self-Reported Health and Health Care Utilization**

The proportion of Gulf War veterans who reported their health as excellent (3.6%) or very good (10.3%) was significantly lower ( $P < 0.001$ ) than the proportion of Gulf Era veterans who reported their health as excellent (6.1%) or very good (16.2%). Significant differences were also observed for the mean number of doctors' visits in the past 12 months between Gulf War and Gulf Era veterans (4 visits vs 3.5 visits, respectively,  $P < 0.0001$ ) and mean number of overnight hospitalizations in the past 12 months (0.26 vs 0.20, respectively,  $P < 0.0001$ ).

**DISCUSSION**

Twenty-five years after the war, Gulf War veterans continue to report significantly poorer health than veterans who did not deploy. Gulf War veterans reported a significantly higher prevalence of chronic illnesses, including cardiopulmonary diseases (obstructive pulmonary disease, tachycardia, coronary heart disease, hypertension, asthma) and neurological diseases (neuralgia, seizures, migraine headaches). Reporting of gastrointestinal disease among the Gulf War deployed was also notable, including provider-diagnosed gastritis and application of the ROME criteria to symptom scales to identify probable irritable bowel syndrome and functional dyspepsia. Diseases that have been associated with Gulf War service—such as Gulf War Illness presenting as chronic multi-symptom illness, chronic fatigue syndrome, and fibromyalgia and dermatitis<sup>20,21</sup>—were also significantly more likely to be reported by the Gulf War deployed. Gulf War veterans also reported more health care utilization than Gulf Era veterans.

Although the prevalence of many of the diseases measured is higher in Gulf War veterans, the population as a whole (ie, Gulf War and Gulf Era veterans) has a high burden of chronic disease, irrespective of deployment, which suggests that military service, not just deployment to a combat theater, may have long-term health consequences. This is not unique to Gulf War and Gulf Era veterans; studies have shown that the burden of chronic disease is high in the veteran population. Veterans report poorer health and functioning than civilians and those in the National Guard or reserve,<sup>22</sup> are more likely to be obese,<sup>23</sup> and are more likely to be diagnosed with multiple chronic conditions.<sup>24–26</sup> In the current study, 79% of the total population reported at least one chronic medical condition (82% in Gulf War veterans, 78% in Gulf Era veterans;  $P < 0.0001$ ) and 45% screened positive for at least one mental health condition (52% in Gulf War veterans and 39% in Gulf Era veterans;  $P < 0.0001$ ). The average number of self-reported chronic medical conditions for the population was 3.5 (3.7 in Gulf War veterans and

**TABLE 2.** Unweighted Frequency and Weighted Prevalence Estimates of Self-Reported Conditions

Condition*	Gulf (n = 8,104); n (%) <sup>†</sup>	Gulf Era (n = 6,148); n (%) <sup>†</sup>	aOR (95% CI) <sup>§</sup>
Amyotrophic lateral sclerosis	11 (0.14)	4 (0.05)	4.32 (0.82, 21.74)
Gulf War Illness <sup>‡</sup>	3,427 (43.9)	1,158 (20.3)	3.06 (2.78, 3.83)
Chronic Fatigue Syndrome	1,011 (11.8)	288 (5.3)	2.36 (1.94, 2.86)
Irritable bowel syndrome <sup>§</sup>	1,828 (24.4)	804 (14.3)	2.10 (1.79, 2.45)
Functional dyspepsia <sup>§</sup>	2,059 (27.7)	902 (15.9)	1.94 (1.75, 2.17)
Neuralgia	795 (9.4)	407 (6.3)	1.65 (1.40, 1.95)
Gastritis	1,604 (20.2)	810 (14.3)	1.59 (1.35, 1.73)
COPD	722 (8.4)	377 (6.3)	1.48 (1.23, 1.78)
Fibromyalgia	408 (3.7)	188 (2.9)	1.48 (1.15, 1.91)
Tachycardia	680 (8.1)	360 (5.9)	1.47 (1.20, 1.79)
Dermatitis	2,212 (27.4)	1,219 (21.1)	1.44 (1.27, 1.63)
Rheumatoid arthritis	808 (9.9)	452 (7.9)	1.40 (1.17, 1.67)
Seizures	253 (2.7)	111 (2.0)	1.38 (1.03, 1.85)
Multiple sclerosis	57 (0.6)	35 (0.5)	1.35 (0.72, 2.51)
Coronary heart disease	535 (5.6)	396 (5.3)	1.32 (1.09, 1.59)
Migraine headaches	1,624 (20.3)	904 (16.1)	1.30 (1.15, 1.47)
Hypertension	3,456 (43.0)	2,459 (40.0)	1.22 (1.10, 1.35)
Asthma	856 (10.2)	553 (9.0)	1.22 (1.04, 1.44)
Genital organ disease	424 (5.1)	274 (4.6)	1.17 (0.93, 1.47)
Arthritis not specified	2,736 (33.9)	1,866 (31.8)	1.16 (1.05, 1.29)
Melanoma	230 (2.5)	183 (2.7)	1.15 (0.87, 1.52)
Parkinson disease	58 (0.5)	33 (0.5)	1.15 (0.59, 2.24)
Diabetes	1,112 (13.2)	820 (13.2)	1.13 (0.97, 1.31)
Other cancer	505 (5.2)	399 (5.6)	1.12 (0.91, 1.37)
Other endocrine disorder	745 (7.4)	542 (8.0)	1.09 (0.87, 1.33)
Other autoimmune disorder	276 (3.0)	179 (3.0)	1.08 (0.83, 1.41)
Osteoarthritis	914 (10.1)	704 (10.9)	1.06 (0.92, 1.23)
Skin cancer	488 (4.4)	418 (5.4)	1.06 (0.88, 1.29)
Brain cancer	30 (0.3)	19 (0.3)	1.02 (0.47, 2.21)
Repeat bladder infections	314 (2.4)	194 (2.8)	1.00 (0.76, 1.33)
Stroke	191 (2.2)	145 (2.4)	0.99 (0.75, 1.32)
Hepatitis	242 (3.5)	197 (3.6)	0.97 (0.75, 1.26)
Cirrhosis	84 (0.9)	68 (1.27)	0.67 (0.42, 1.10)

aOR indicates adjusted odds ratio; CI, confidence interval; COPD, chronic obstructive pulmonary disease.

\*Based on the question "Has your doctor ever told you that you have any of the following conditions?"

<sup>†</sup>Each weighted percentage is based on the number of respondents for specific health outcome/condition.

<sup>‡</sup>Based on the question "Since January 1991, have you ever experienced unexplained multisymptom illness that lasted 6 months or longer?"

<sup>§</sup>Based on ROME criteria. Adjusted for age, BMI, smoking, sex, race, branch, and unit component.

2.9 in Gulf Era veterans;  $P < 0.0001$ ). The average BMI in the population was 29.8, which borders on the 30-point cutoff for being classified as obese (29.8 in Gulf War veterans and 29.7 in Gulf Era veterans). Fifty-four percent of the population are current or former smokers (55.5% in Gulf War veterans and 52.9% in Gulf Era veterans,  $P < 0.01$ ). These findings underscore the importance of population health management of chronic illness as well as interventions aimed at reducing obesity and smoking in this veteran population.

The prevalence of positive screens for mental health conditions in both the Gulf War and Gulf Era population was notable. Although studies have examined the prevalence and characteristics of mental health conditions among Gulf War veterans,<sup>27–32</sup> there is limited information on the prevalence of mental health conditions in Gulf Era veterans who served during that time period. Among this group, the prevalence of screening positive for PTSD (past 4 weeks) and major depressive disorder (past 2 weeks) was 11.5% and 22.9%, respectively. These prevalence estimates are higher than those

**TABLE 3.** Unweighted Frequency and Weighted Prevalence of Screening Positive for Selected Mental Health Conditions

Condition	Gulf (n = 8,104); n (%) <sup>‡</sup>	Gulf Era (n = 6,148); n (%) <sup>‡</sup>	aOR (95% CI) <sup>§</sup>
PTSD (past 4 wk)*	1,630 (20.9)	621 (11.5)	1.93 (1.67, 2.24)
Major depressive disorder (past 2 wk) <sup>†</sup>	2,130 (32.9)	1,151 (22.9)	1.56 (1.41, 1.73)
Other depressive disorder (past 2 wk) <sup>†</sup>	1,410 (23.5)	918 (19.1)	1.24 (1.08, 1.38)
Other anxiety syndrome (past 4 wk) <sup>†</sup>	1,452 (18.7)	877 (14.4)	1.34 (1.17, 1.54)
High somatic symptom severity (past 4 wk) <sup>†</sup>	1,286 (16.1)	482 (8.3)	2.10 (1.79, 2.45)

aOR indicates adjusted odds ratio; CI, confidence interval; PTSD, posttraumatic stress disorder.

\*Measured by the PTSD Checklist Civilian Version (PCL-17).

<sup>†</sup>Measured by the Physician Health Questionnaire (PHQ).

<sup>‡</sup>Each percentage based on complete case analyses for each screening instrument.

<sup>§</sup>Adjusted for age, BMI, smoking, sex, race, branch, and unit component.

reported in the National Comorbidity Survey Replication (NCS-R), a nationally representative mental health study of noninstitutionalized US adults that included an in-person survey with a diagnostic interview.<sup>33</sup> The 12-month prevalence of PTSD and major depressive disorder reported from the NCS-R was 3.5% and 6.7%, respectively. Interestingly, the prevalence of a positive screen for PTSD in the Gulf Era veterans reported in this study was similar to the prevalence of a positive screen for PTSD in Operation Enduring Freedom and Operation Iraqi Freedom-era veterans (10.9%).<sup>34</sup> This suggests that military service, or the characteristics of those who choose military service, may be associated with increased risk for PTSD. Although speculative, research has identified an elevated prevalence of early childhood adversity and preservice mental health disorders among veterans in the all-volunteer era.<sup>35,36</sup> These findings, coupled with results from the current study, underscore the importance of routine assessment of mental health disorders among all veterans as a component of comprehensive health maintenance.

A significant body of literature has documented poor health outcomes associated with service in the Gulf War.<sup>21,37–42</sup> The Gulf War provides a potent example of the hazards associated with military deployments; occupational hazards anticipated during wartime were complicated by a variety of environmental and man-made hazards that were unique to this conflict. The frequent threat of chemical weapons exposure, challenging operational conditions including temperature extremes, sand and dust storms, and smoke and fire from burning oil wells, and other fires added to the potential exposure threats in theater. Military preparedness training for deployment, however, may contribute to hazard exposure and risk of illness or injury.

Forty-four percent of Gulf War veterans reported that they had experienced unexplained multisymptom illness, also known as Gulf War Illness, since 1991 compared with 20% of Gulf Era veterans. GWI, arguably the signature illness/injury of the Gulf War, presents as cluster of medically unexplained symptoms including fatigue, pain, gastrointestinal disorders, and neurological symptoms with no clearly identifiable underlying medical cause.<sup>21,40</sup> There is no single agreed-upon, validated case definition.<sup>43</sup> The symptoms of GWI are similar to symptoms associated with age-related chronic conditions such as cognitive function,<sup>44</sup> pain,<sup>45</sup> and fatigue,<sup>46</sup> illustrating the complexity of identifying exposure-related, symptom-based outcomes among members of an aging population with a high prevalence of comorbid chronic medical conditions.<sup>47</sup> The symptoms of GWI may be exacerbated by, or attributed to, a chronic medical condition in cases where GWI is comorbid, making it difficult to estimate the true prevalence.

### Strengths and Weaknesses

This study has several strengths; it is the largest and longest epidemiological study of Gulf War and Gulf Era veterans. The sample contains VA health care users and nonusers, the latter a group that is not often captured in VA research. We were able to achieve a 50% response rate, which is a very desirable outcome nearly 20 years after the initial survey. Although weights were developed to adjust for the sampling scheme and nonresponse, we acknowledge the possibility of nonresponse bias. We performed nonresponse analyses using data from the current and baseline study. Propensity modeling was used to assess attrition between waves and compute nonresponse adjustment (using calibration and bootstrapping). Pearson moment correlations of response propensity with frame variables in the model and selected health outcomes were analyzed to identify statistically significant correlations. Results indicated that the nonresponse bias was mitigated through weight adjustment via calibration for the majority of the important variables in the study. Even after adjustment, significant correlations of outcomes and response propensities for PTSD and self-reported health, however, remained significant; respondents tended

to have lower values of PTSD (ie, no PTSD) compared with nonrespondents and higher self-reported health compared with nonrespondents. Therefore, those estimates need to be interpreted with this caveat. A final limitation is that the data presented here are cross-sectional, and therefore do not inform about the rate of disease development over time. Future research on this cohort will leverage the longitudinal design of the study to focus on change in health status (physical and mental) among Gulf War and Gulf Era veterans over the course of the 20-year period after the Gulf War.

Our findings demonstrate that almost 20 years after the Gulf War, Gulf War veterans continue to report poorer health than Gulf Era veterans. Although the prevalence of self-reported health conditions and positive screens of mental health conditions are higher in Gulf War veterans, the prevalence in the Gulf Era veterans indicates a significant burden of disease in the population as a whole, suggesting that military service, not solely deployment, has long-term health consequences. Population health management of chronic disease and interventions to reduce obesity among veterans using the VA health care system is necessary to improve health outcomes. For private sector health care providers treating veterans, it is important to ask about military service and screen appropriately for conditions that are associated with military service.

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